ORD Animal Feeding Operation Research Abstracts - draft 4/8/04

Current and recent ORD research addressing Animal Feeding Operations and Concentrated Animal Feeding Operations (AFOs/CAFOs) is listed below. Project title, abstract, products, start and expected completion dates, and contact information are provided. The research is organized into four categories or major research areas: Air, Surface and Ground Water, Pharmaceuticals and Pathogens, and Management Practices. Within each of these categories the projects are divided into major themes associated with the risk assessment/management paradigm: Stressor Characterization, Fate and Transport, Effects Characterization, and Management Practices.

AIR

Stressor Characterization

- Ammonia Emissions from Animal Husbandry Operations. Efforts to improve emission factors from agricultural sources initially focused upon the swine industry beginning in 1997. In FY 2003, poultry facility emissions were initiated. During FY 04, ammonia measurements from swine operations will be ending, but ammonia measurements from poultry operations will continue. In addition, an investigation for conducting cattle CAFO operation testing will begin.

Open-path optical remote sensing (OP-ORS) and direct exhaust fan sampling with continuous emission monitors will be continued at poultry operations. Cooperative work with the Univ. of Kentucky will concentrate upon broilers while work with Purdue Univ will emphasize layers. A new OP-ORS effort in support of NRMRL-CI will be conducted at a naturally ventilated swine facility to determine acute impacts of air emissions upon surface and ground waters. Initial measurements will be made at cattle feedlots in cooperation with USDA and land grant universities. A new tuneable diode laser system will be integrated into this program to increase sensitivity for specific gases. A peer-reviewed paper describing the use of OP-FTIR to evaluate lagoon controls will be published.

Product:

Doorn, M., D. Natschke, and P. Meeuwissen. Review of Emission Factors and Methodologies to Estimate Ammonia Emissions from Animal Waste Handling (Project Summary). EPA/600/SR-02/017, 2002.

Doorn, M., D. F. Natschke, and P. C. Meeuwissen. Review of Emission Factors and Methodologies to Estimate Ammonia Emissions from Animal Waste Handling. U.S. Environmental Protection Agency, Washington, D.C. EPA/600/R-02/017, 2002.

This report summarizes and discusses recent available U.S. and European information on NH3 emissions from swine farms and assesses the applicability for general use in the U.S., and North Carolina in particular. In addition, limited information on NH3 emissions from other farm animals is included, as well as some information on methane emissions from anaerobic animal waste lagoons and nitrous oxide emissions from swine waste spray fields. The report discusses a comprehensive mass balance approach that may be used to estimate emissions for certain livestock and poultry operations.
The emission rates for the houses calculated by various methods show good agreement and suggest that the houses are a more significant source than previously thought. It is believed that there is enough basis to recommend a general emission factor for houses of 3.7 ¿ 1.0 kg NH3/year/finisher pig or 59 ¿ 10 g NH3/kg live weight/year. This value is supported by the 4.3 kg NH3/year/finisher

pig reported for several pull-plug houses which were tested in the summer of 2000. For lagoons, it was found that there is good similarity between the field test results and the number calculated by a mass balance method. The suggested annual NH3 emission factor based on field tests at one swine farm lagoon in North Carolina is 2.4 kg/year/pig. The emission factor for lagoons is based on field tests at only one lagoon and is considered to be less accurate than the emission factor for houses. Emission rates from spray fields were estimated using a total mass balance approach, while subtracting the house and lagoon emissions. The total emission rates for finishing pigs at the test farm compared well to the total rate established by a mass balance approach based on nitrogen intake and volatilization. Therefore, it was concluded that a mass balance approach can be helpful in estimating NH3 emissions from swine farms. Assuming that the swine population at the test farm was a self-sustaining population, similar to the average swine population in North Carolina, a general emission factor of 7 kg NH3/pig/year was developed. This emission factor is comparable to three general European emission factors, which varied from 5 to 6 kg NH3/pig/year.

Product:

R. C. Shores. Ammonia Emission Factors from Swine Finishing Operations (EPA/600/A-01/037). U.S. Environmental Protection Agency, Washington, D.C., 2001.

The paper presents results from two new studies at swine finishing facilities. (NOTE: Concentrated animal feeding operations (CAFOs) are being examined in several regions of the U.S. as major sources of ammonia and particulate matter precursors. EPA's National Risk Management Research Laboratory (NRMRL) has previously measured ammonia concentrations around, and estimated emissions from, a swine production facility). The new data were collected for tunnel-ventilated pull-plug swing finishing barns using chemiluminescent ammonia measurements from the exhaust fans. Open-path Fourier transform infrared (OP-FTIR) measurements of a naturally ventilated pit rechange barn and its lagoon are used to develop emission factors in the second study. The data suggest that the barns are a significant source of ammonia and that current emission factors are not markedly different from these new data.

Dates: FY 1997 - FY 2005
Contact: Bruce Harris, ORD/NRMRL, 919-541-7807

- Ambient Ammonia Sensors (Concentrated Animal Feeding Operations). Agricultural activities and waste from livestock are a significant source of atmospheric ammonia, which can have adverse environmental and health effects. The AMS Center has completed a performance verification test to gauge how well present technologies monitor ammonia in normal operating conditions from these type sources. Testing was conducted in two phases. Phase I testing was at a commercial swine farm in Ames Iowa lasting from September 8 to October 3, 2003, while Phase II testing was at a cattle farm nearby from October 13 to November 14, 2003. Monitors to be tested in this performance verification will include both open-path systems and point source monitors. Performance parameters to be addressed are: accuracy, linearity, precision, calibration drift, zero drift, response time, ease of use, and data completeness. Reference samples were collected using an EPA Standard Method using annular denuder technology. Seven vendors participated. The USDA partnered with the AMS Center on this project by providing in-kind and direct contributions.
Products: Reports are proposed for distribution on the ETV Web Site <www.epa.gov/etv/centers/center1>by mid-Spring 2004.
Dates: Testing is complete. EPA-ORD-National Exposure Research Laboratory (NERL) Technical and QA report reviews will begin about December 2003/January 2004.
Contact: Robert Fuerst, ORD/NERL, 919-541-2220

Fate & Transport

-Climate Change and N Deposition. This project investigates the potential influence of climate change on wet deposition of reduced nitrogen (NH4+) across the U.S. The concentration of ammonium-nitrogen in precipitation is known to increase with temperature, owing to temperature dependent ammonia source strengths (natural and agricultural soils, vegetation, animal waste). Using existing databases, the influence of temperature on wet deposition of ammonium will be assessed at approximately 200 U.S. sites. Using this site-specific information, spatio-temporal deposition models will be constructed to estimate regional-scale deposition impacts for specific climate change (temperature/precipitation) scenarios. These predictive models can also be used modularly within suitable atmospheric models. The goal of the project is to understand the relationship between NH4+ deposition and long-term changes in temperature and precipitation amounts, as well as subsequent changes in NOx and SO2 emissions, and identify those regions that may be at greatest risk from increased deposition rates.
Dates: FY 2001- FY2005
Contact: John Walker, ORD/NRMRL, 919-541-2288

-Fate of Atmospheric N in Agricultural Regions. Globally, domestic animals are the largest source (22 Tg N yr-1, 1 Tg = 1012 g) of atmospheric NH3, comprising approximately 40% of natural and anthropogenic emissions combined, while synthetic fertilizers and agricultural crops together contribute an additional 12.6 Tg NH3-N y-1 (23% of total emissions) In and downwind of agricultural regions (including crop and animal production), NH3 and its reaction product NH4+ aerosol therefore represent a significant component of the atmospheric nitrogen budget. This project seeks to better understand the fate of atmospheric NH3 in and downwind of agricultural regions. Specifically, we will investigate the influence of agricultural NH3 emissions on the concentrations and chemical characteristics of inorganic PM2.5 as well as deposition/emission of NH3 to/from terrestrial and aquatic ecosystems.

These aspects of nitrogen cycling in agricultural regions currently represent potentially important and poorly characterized connections between agricultural and human/ecosystem health. This project will provide new information on atmospheric concentrations of PM; provide field data to evaluate air quality models; improve emission estimates for NH3; and improve the understanding of linkages between emissions, PM formation, and deposition to support air quality modeling.
Dates: FY 2003 - FY2005
Contact: John Walker, ORD/NRMRL, 919-541-2288

Fate and Transport and Effects Characterization

- Atmospheric Deposition and Watershed Impacts of Ammonia and other N compounds. In a joint venture with the NRMRL water quality staff, the emissions from a 5000 head hog finishing operation will be measured and the acute impact of those emissions on the air, soils and streams on or adjacent to the facility will be determined. The objective is to characterize the atmospheric chemistry of NH3 and NH4+-based PM2.5 in agricultural regions and assess the influence of agriculture on total PM2.5 in such regions. Seasonal measurements will be made starting in the Spring of 03 before the installation of a new system to reduce farm emissions and continuing for one year. Cooperation with the USGS, NCDENR and EPA-Athens will provide a complete measure of the facility upon the ground water resources.We propose to characterize the impact of the Lizzie swine production facility on local atmospheric deposition of ammonia. Weekly-average ambient ammonia concentrations will be measured along transects extending from the housing/lagoon complex out to 0.5 km. By applying measured turbulence statistics and empirical models of canopy resistance to these concentration data, ammonia deposition will be estimated. Using this approach, we will be able to characterize the spatial variability in ammonia deposition out to a distance of 0.5 km. We will also assess the seasonality of deposition rates. Using our results along with ammonia emissions measurements, we will be able to calculate the fraction of emitted ammonia that deposits within 0.5 km of the production facility. The dataset generated from this project will be used to estimate the impact of CAFOs on dry deposition of NH3 to neighboring and downwind ecosystems and relate potential emission

reductions to reductions in local deposition..
Dates: Oct 02, 2002 - Sep 30, 2005
Contact: John Walker, ORD/NRMRL, 919-541-2288

SURFACE AND GROUNDWATER

Stressor Characterization

- **Modeling the Distribution of Nonpoint Nitrogen Sources and Sinks in the Neuse River Basin of North Carolina, USA**. This study quantified nonpoint nitrogen (N) sources and sinks across the 14,582 km^2 Neuse River Basin (NRB) located in North Carolina, to provide a tabular database to initialize in-stream N decay models and graphic overlay products for the development of management approaches to best achieve established N reduction goals. Modeling efforts included the development of a remote sensing derived land-cover classification to identify individual landscape modeling elements, followed by mass-balance modeling to quantify potential sources of excess N, and precipitation event driven hydrologic modeling to effectively transport N to individual stream reaches with subsequent labeling of transported N values corresponding to source origin. Results indicated that agricultural land contributed 55.3% of the total annual NPS-N loadings, followed by forested land at 23.0% (background), and urban areas at 20.9%. Average annual N source contributions were quantified for agricultural (1.4 kg/ha), urban (1.2 kg/ha) and forested cover types (0.5 kg/ha). NPS-N source contributions were greatest during the winter (39.8%), followed by spring (31.7%), summer (28.2%), and fall (0.3%). Seasonal total N loadings shifted from urban and forest dominated sources during the winter, to agricultural sources in the spring and summer. A quantitative assessment of the significant NRB land-use activities indicated that high and medium density urban development (>35% impervious) were the greatest contributor on NPS-N on a unit area basis (1.9 and 1.6 kg/ha/yr, respectively), followed by row crops and pasture and hay agricultural cover types (1.4 kg/ha/yr).
Dates: FY 1998 - FY 2003
Contact: Ross Lunetta, ORD/NERL, 919-541-4256

Fate & Transport

- An Object-oriented Model for Nitrogenous Pollutants from Swine Waste Land Application. Agricultural nonpoint source pollutants are increasingly problematic with respect to air quality in North Carolina and other southeastern states. Estimates for North Carolina are that 96% of stream degradation is caused by nonpoint source pollutants and that agriculture is responsible for 67% of that total. Agriculture has been implicated in the deterioration of water quality in the Neuse River and Albemarle-Pamlico watershed through fertilizer-N loss to surface waters and atmospheric transport of volatilized NH3 to downwind waters. Attention has focused on large scale swine production as a nonpoint agricultural N source for coastal rivers and waters. North Carolina presently ranks second among swine producing states. About 101,000 ha of land are devoted to spray fields on 2450 permitted swine production facilities. The extant population of 10 million head generates 48 Gg N per year in waste. Field-applied waste is volatilized as NH3, assimilated into plant matter, mineralized or transformed by microbes or enters surface and ground waters. Accurate description of N fluxes and transformations is necessary to implement management practices that minimize offsite nutrient transport.

The aim of this work is to develop an object-oriented simulation model component for nitrogen transformations occurring in agricultural soils fertilized with liquid swine waste. Accordingly, it is necessary to: 1) design within a modeling framework that permits the soil model to interface with atmospheric and shallow groundwater components; 2) utilize representations for transport, exchange, and reactions that can be efficiently solved by object-oriented numerical methods; and 3) provide for easy

modification of the object system to accommodate a range of representations from explicit to generalized depending upon evolving knowledge of the processes and availability of instance data.
Dates: Oct 01, 1999 - Sep 30, 2002
Contact: Myles Morse, ORD/NCER, 202-564-6827

- **Measuring and Modeling the Source, Transport and Bioavailability of Phosphorus in Agricultural Watersheds**. The linkage between watershed characteristics and the transport of bioavailable phosphorus (BAP) to surface waters is complex as processes that link agricultural P inputs to net BAP losses span a range of scales. Agricultural inputs of P in individual fields represent the primary initial source of BAP in runoff, but the spatially distributed transport pathways, in conjunction with the distribution of initial sources and storage reservoirs (e.g., stream pools), determine the quantity and rate of net BAP exported from a watershed. As a result, a substantial knowledge gap exists between the conservation practices at the field-scale and regulatory needs at the watershed-scale. By necessity, water regulation authorities often look specifically at water quality at selected points in a stream when assessing impacts on a watershed scale. However, authorities working more closely with agricultural producers involved in crop and animal production have focused at the field scale where decisions made by landowners significantly impact source contributions. Decisions at either scale are often made without consideration of the linkages between P sources and transport pathways.
1. Quantify effects of manure management and crop production systems on runoff P losses.2. Determine spatial patterns of sediment and associated P in streams.3. Determine in-stream fate and transport processes of P.4. Evaluate and improve modeling tools used to assess P transport in agricultural watersheds over a wide range of spatial scales.5. Determine relation of P losses with the scale of animal operation.6. Integrate outreach into on-going research efforts.
Dates: Dec 17, 2002 - Dec 16, 2005
Contact: Myles Morse, ORD/NCER, 202-564-6827

- **Emissions of N2O in N. Carolina Water Bodies**. The goal of this project is to assess air quality changes due to nitrous oxide emissions from water bodies to the atmosphere and to link its production with inputs of nitrogen sources. Nitrogen inputs include air borne PM compounds, ammonia, and water borne nitrates. Algal blooms and their contribution to PM are of concern but probably will not be evaluated due to the difficulty of evaluation. Data are scarce from coastal aquatic systems, with literature review producing only two published studies in fresh water ecosystems that identified N-enrichment as an important source of N2O emissions.

Anthropogenic sources of N2O include agricultural soils and wastewater treatment plants. Nitrogen from these sources is one of the causes of poor water quality in rivers and estuaries, contributing to harmful algal blooms, hypoxic conditions, and fish kills. Nitrous oxide is formed due to microbial processes of denitrification and nitrification. Thus increases in nitrogen saturation levels in the aquatic environment should increase production of N2O. This study would determine whether this increase is an important factor to consider in air quality as well as supply additional information on a greenhouse gas.

In FY 2002, I continued periodic sampling and began statistical analyses to determine correlation of N2O off-gassing to external nitrogen sources. External nitrogen inputs from anthropogenic sources, such as agricultural soils and wastewater treatment plants, are one of causes of poor water quality in rivers and estuaries, contributing to harmful algae blooms, hypoxic conditions, and fish kills. Nitrous oxide is formed due to the microbial processes of denitrification and nitrification. Thus increases in nitrogen saturation levels in the aquatic environment should increase production of nitrous oxide. This study would determine whether this increase is an important factor to consider in greenhouse gas emissions. Sampling is done every 3-4 weeks. Parameters measured include: DO, nitrate, nitrite, ammonium, dissolved organic carbon, and phosphorus, water temp, N2O gas concentrations. Air samples are analyzed with a GC/ECD. Water samples are analyzed by Duke University.

For FY 2003, I propose to expand this project to include measurements at a collaborative research site in Lizzie, NC. My role would contribute to the research on nitrogen cycling across air-water boundaries. This

project would project into 2004-2005 as a new technology for hog manure management is to be implemented on this site and would provide for before-after sampling.
Dates: Oct 01, 2001 - Sep 30, 2005
Contact: Lynette Cardoch, ORD/NRMRL, 919-541-0809

Effects Characterization

- Microbiological Impact of Agricultural and CAFO Activities on Surface Water Quality. Previous evidence of microbial contamination of natural waters by agriculture and Concentrated Animal Feeding Operations (CAFOs) has created the necessity to further evaluate the situation. Pathogenic bacteria and pathogenic viruses are often present in the intestinal microflora of humans, as well as animals associated with CAFOs. This creates the potential for pathogen transfer into nearby watersheds, which in term poses a public health threat. The objective of this research is to provide a microbiological evaluation of the Turkey Creek Watershed located in northwest central Oklahoma. This is a priority watershed listed under Section 303D of the Clean Water Act, and is currently the focus of a USGS study on sources of impairment. Nitrogen-isotope ratios of nitrate and detection of organic compounds typical of human wastewater previously indicated that animal and/or human wastes were the major sources of nitrate in Turkey Creek. Therefore, it is important to identify the species source of fecal contamination as well as specific pathogens that may be present in the watershed. This research project consists of two phases. The first phase is dedicated to bacterial source tracking using the bacterium E. coli as the indicator organism. The methodology is based on antibiotic resistance analysis in combination with a statistical discriminant analysis. The second phase will involve identification of specific viral and bacterial pathogens in the water. The target microorganisms of this project are the human enteroviruses (poliovirus, coxsackievirus, echovirus) and the bacteria Yersinia enterocolitica, and Campylobacter jejuni. The methodology will be based on hollow-fiber ultra-filtration and real-time PCR technology. The application of the results will aid in the development of TMDLs and risk management strategies for optimizing land use practices in the animal industry.

Products:
(1) Paper on sources of coliforms in a TMDL-listed watershed *(planned)*,
(2) paper on recovery and identification of pathogens in a TMDL-listed watershed *(planned)*.
Dates: 04/01/2002 - 09/30/2005
Contact: Yolanda Olivas, ORD/NRMRL, 580-436-8729

- Effects of Concentrated Animal Feeding Operations (CAFOs) on Ground Water Quality. This research focuses on the potential for ground water contamination from swine CAFOs in Oklahoma. Three CAFOs have been selected for study, including a new farrowing sow operation (Beaver), an existing nursery operation (Canton), and a closed combined facility (Cimarron Pork). For the Beaver and Cimarron Pork facilities, ground water samples were simply obtained from existing wells and analyzed for standard water quality indices as well as total organic carbon, nutrients, cations/metals, pharmaceutical chemicals, estrogens, and pathogen indicator organisms. The Canton field site study was much more extensive, and site characterization included core acquisition and logging, geoprobe electrical conductivity logging, completion and monitoring of numerous cluster wells, stable isotope studies, slug testing, and other activities over the three-year monitoring period. In addition, in coordination with EPA Region 6, on-site access was obtained allowing characterization in the land application area. Data from this well-characterized site will be used to develop a ground water flow model. Results from all of these studies will be used to determine whether ground water aquifers are at risk, and to develop sound risk management strategies for sustainable development. Additional work will continue utilizing EDC funds to optimize the estrogen method for additional QA/QC.
Products:
(1) Paper on analytical method to monitor natural and synthetic hormones associated with risk management

of CAFOs *(completed - J. Chromatogr. A, 1017 (2003) 167-185)*;
(2) Paper on the potential of swine CAFOs to contribute EDCs to ground water *(in press - Proceedings, Battelle Conference (2003)*,
(3) EPA report on potential of swine CAFOs to contribute COCs, pathogens, and EDCs to ground water *(in preparation)*;
(4) paper on Canton site ground water flow model *(planned)*,
(5) paper on Canton site field study *(planned)*.
Dates: 01/01/2000 - 09/30/2004
Contact: ORD/NRMRL - Steve Hutchins, 580-436-856; Elise A. Striz, 580-436-8594

PHARMACEUTICALS AND PATHOGENS

Stressor Characterization

- Evaluation of Bioaerosols Associated with Concentrated Animal Feeding Operations. Bioaerosol monitoring involves taking measurements of viable (culturable and non-culturable) and nonviable microorganisms in indoor and outdoor environments. Bioaerosol concentrations are being measured around swine production facilities. The air samples that are collected are being analysed for antibiotic resistant bacteria and endotoxin. The amount of bacteria and endotoxin are being determined in the air around the swine barns at defined distances. The impactors used for the collection of airborne bacteria are the Andersen Two-Stage Samplers. Culturable bacteria are analyzed using the Kirby-Bauer Disk Diffusion method for antibiotic susceptibility testing. Button Aerosol Samplers fitted with 2.0 micron, 25mm polycarbonate filters or Endotoxin-free pre-sterilized 0.45 micron, 37mm polycarbonate filters was used for the collection of endotoxin. Endotoxin are analyzed using the *Limulus* amebocyte lysate (LAL) assay.
Dates: FY 2002 - FY2004
Contact: ORD/NRMRL - Kim Mcclellan, 513-569-7214; Ed Barth, 513-569-7669; Vince Gallardo, 513-569-7176.

- Determine Pathogen Density in Aerosols from Animal Agriculture Operations. The purpose of this work is to determine the nature of aquatic stressors that may be released from animal agricultural operations so that future research can be focused on developing strategies to mitigate any such stressors that are emitted in significant amounts via this mechanism.
Dates: Expected completion 9/05.
Contact: John Haines, ORD/NRMRL, 513-569-7446

- Detection of Pathogens in Drinking Water (SEER 2). Project investigators developed a polymerase chain reaction (PCR)-based technique to detect *E. coli* 0157:H7 cells in environmental samples using previously reported PCR primers for the specific detection of genes involved in biosynthesis of 0157 polysaccharide and H7 flagella antigens. They also developed a multiplex PCR technique to simultaneously detect animal cells (sheep, cow, human, or horse) and *E. coli* 0157:H7. PCR primers to detect animal cells were based upon the known DNA sequences of J region and C region of the regulatory D-loop of mitochondrial DNA. *E. coli* 0157:H7 (ATCC 43894) was used as the pathogen standard for PCR procedure development. *E. coli* DH5 and non-O157:H7 *E. coli* strains isolated from cattle feces were used as negative controls. Experimental samples were taken from water troughs of the various animals being studied as possible contamination sources. The *E. coli* 0157:H7 titer detected by the PCR assay had as few as six cells. Two hundred *E. coli* 0157:H7 cells were easily detected after 38 amplification cycles. The D-loop primer sets were able to detect and differentiate the presence of human from horse or cattle, but not sheep DNA samples.
Dates: Aug 15, 1999 - Aug 14, 2002
Contact: Myles Morse, ORD/NCER, 202-564-6827

- Rapid and Sensitive Electrochemical-based Method for Improved Detection of *Cryptosporidium parvum* in Water - Phase I. *Cryptosporidium parvum*, a waterborne pathogen, is a serious threat to the Nation's water supply. It does not respond to common antibiotics and resists water purification treatments. It is of interest to not only monitor *C. parvum* oocysts in drinking water, but also to study their fate in the environment from various sources (e.g., cattle) in lakes and streams. This is especially important today in assessing vulnerability to biological terrorism. However, current U.S. Environmental Protection Agency (EPA) methods (ICR, 1622, and 1623) for the detection of *C. parvum* in water are inadequate for such studies. Several aspects inhibit extensive use of the methods: expense ($400-$750 per sample), time (a few days to several weeks), the need for highly skilled personnel, and poor sensitivity and repeatability (approximately 100 oocysts/L detection limit). Vegrandis, Inc.'s approach promises to provide significant improvements over current EPA methods.

During Phase I, a new concept will be evaluated for capturing oocysts and tested on a macroscale, first on laboratory-prepared samples, and second on resuspended pellets from the filtration and concentration portions of EPA Method 1623. Extrapolation of macroscale results to the microscale will allow for the estimation of detection limits and response time, and thus, determine feasibility for Phase II. Parameters based on macroscale studies also will be considered for optimizing a microelectrochemical method that may substitute for the current immunofluorescence assay and microscope detection of the EPA method. If Phase I is successful, Phase II will involve downsizing to the microscale, developing direct sampling from environmental water sources, and automating the process using miniaturization strategies that allow filtration to be minimized or eliminated and make onsite analysis possible. The commercial application includes developing water monitoring methodologies and devices.

Several innovations that contrast greatly from EPA methods are involved. First, detection of *C. parvum* oocysts will utilize electrochemical detection instead of fluorescence methods that suffer from interfering background fluorescence (e.g., algae). Second, the capturing antibody (IgG) is based on recognition of oocyst coat proteins instead of carbohydrates (IgM), thereby further minimizing interferences from other organisms. Third, the capture approach holds promise for high-volume throughput capability, which may lead to the elimination of filter use. Fourth, with microscale electrochemical detection, immunoassembly sites will be located within a few microns of the detector, which will greatly improve speed and sensitivity of detection. These are patent-pending approaches originally developed by the Principal Investigator and her research team, to which Vegrandis, Inc., has an exclusive license.
Dates: Apr 01, 2003 - Sep 01, 2003
Contact: Myles Morse, ORD/NCER, 202-564-6827

- Molecular Detection of Anaerobic Bacteria as Indicator Species for Fecal Pollution in Water. Fecal contamination of aquatic environments is a continuing problem, afflicting many regions of the U.S. Although the health risks to humans are well known, much remains to be learned about concomitant effects on microbial communities. Often the source of fecal contamination cannot be determined with certainty. For example, runoff from non-point sources such as manure from dairy pastures, failing septic systems, and overloads at sewage treatment facilities may all be candidates. The standard indicators for fecal pollution are fecal coliforms, which do not distinguish between human and animal sources. We have developed a novel indicator system based on the anaerobic gut bacterial group Bacteroides/Prevotella.. We do not grow the indicator bacteria, but instead measure molecular markers amplified from bacteria filtered from the water. With this method we can already distinguish human from cow fecal pollution in both estuarine and river waters. We propose to study a small, nutrient-rich, fecally-polluted estuary, Tillamook Bay, Oregon, and its tributary rivers. The objectives of this proposal are, first, to develop additional markers from other biologically-important polluting species, such as waterfowl. Second, we will identify the indicator strains or species that are host-specific. Finally, we will make the indicator system quantitative, to allow estimation of both the amount of total pollution in the water, and the proportions of different sources of fecal pollution.

Resulting Improvement in Risk Management: This research will result in an indicator system for fecal pollution which can be used in wetlands, estuaries, streams, and lakes. It will allow managers to distinguish

the sources of fecal pollution in water, leading to better management practices to maintain ecosystem integrity and reduce the risk to human health.
Dates: Nov 01, 1999 - Oct 31, 2002
Contact: Myles Morse, ORD/NCER, 202-564-6827

- **Methods for Detection of *Mycobacterium paratuberculosis* in Environmental Samples**. M. paratuberculosis, a member of the M. avium complex (MAC), is the causative agent for Johne's disease in cattle. Johne's disease is a slow, progressive infection of the intestine in cattle. M. paratuberculosis infection often results in diarrhea and wasting of cattle. It has been reported that approximately 33% of dairy herds may be infected with this organism. In addition to well - documented evidence of M. paratuberculosis as the causative agent of Johne's disease in cattle, there has been evidence linking M. paratuberculosis with Crohn's disease, a chronic inflammatory disease of the intestinal tract in humans. It has been proposed that transmission of M. paratuberculosis via water contaminated with cattle feces may be one route of infection. Thus human infection may occur through exposure by drinking or contact with contaminated water. Methods for detection of this organism are critically needed before initiation of occurrence or exposure studies. This research proposes development of a PCR method based on amplification and detection of M. paratuberculosis species specific insertion sequence IS 900.
Dates: Aug 01, 2003 - Aug 01, 2006
Contact: ORD/NERL - Terry Covert, 513-569-7318; Stacy Pfaller, 513-569-7893

- **Measurement of Endocrine Disrupting Chemicals in West Virginia's Waterways: Seasonal Comparisons for Agricultural, Industrial and Residential Areas.** Fourteen different river locations within West Virginia were chosen for the sampling of 23 chemical compounds that have been shown to have endocrine disrupting potential. This study was designed to compare potential surface water contamination for rivers draining agricultural, industrial, and residential areas at various river stage levels for different seasons of the year. The specific chemicals that were measured were estriol, estrone, 17β-estradiol, 17 α-estradiol , 17α- ethinylestradiol, diethylstilbestrol, trans-testosterone, cis-testosterone, progesterone, nonylphenol (isomer mix), 4-n-octylphenol, 4-tert-octylphenol, bisphenol A, pentachlorophenol, 2,4,6-trichlorophenol, tetrabromobisphenol A, total phenylphenol, nonylphenol monoethoxylate isomer mix, nonylphenol diethoxylate isomer mix and 2-diethylhexylphthalate. The results of the study showed that (1) agricultural areas were as likely as industrial areas to be the source of nonyphenols; and (2) agricultural areas were less likely to be the source of reproductive steroidal compounds than residential areas. Among the various reproductive steroid hormones, only cis-testosterone has been detected. To date, the river stage level has not had a significant effect on analytical results and industrial and residential sites had higher pollutant concentrations than agricultural sites.
Completion Date: Final
Contact: John Cicmanec, ORD/NRMRL, 513-569-7481

Fate and Transport

- **Fate of CAFO EDCs Applied to Land**. The goal of this project is to understand the fate of EDCs (steroid hormones) after application of animal waste to land. In other words, is the most common animal waste disposal method, land application, a good treatment method for the EDCs in animal waste? This research is employing laboratory soil columns and large-scale soil lysimeters to develop fate and transport models of EDCs in the soil and the subsurface. Swine waste is under study first.
Contact: Carl Enfield, ORD/NRMRL, 513-569-7489

- **Land Treatment of Biosolids/CAFO Waste.**. A common disposal practice for municipal biosolids and CAFO manures is to spread this material on agricultural fields as a soil amendment. Recently, questions have arisen about this practice. One concern is that current restrictions are not sufficiently protective of pathogen exposure. Another concern is that EDCs present in the solid are contaminating the environment

through runoff and groundwater infiltration. To evaluate these questions, the concentrations of pathogens, other microbes, nutrients, and EDCs will be measured before and after biosolids and manure application to land. Transport and fate of the analytes will be studied and when possible, kinetic rates will be calculated to characterize the system.
Dates: Jan 2003 - Dec 2008
Contact: ORD/NRMRL - Carolyn Acheson,, 513-569-7190; Ronald Herrmann, 513-569-7741

- Experimental Study of Overland Transport of *Cryptosporidium parvum* Oocysts. Oocysts are produced in many animals, but the primary concern is for production in dairy or meat cattle, particularly in calves where as many as 109 oocysts may be produced per calf per day and shed to the ground surface in fecal material. The concern is for potential movement of oocysts during storm runoff events. It is currently unknown whether oocysts are transported primarily along with sediment material to which they may be attached, or as "free-floating" bodies. In either case, oocysts may be carried into streams and eventually may infect water supplies. Little is known, however, about their transport properties, so that it is currently difficult to evaluate actual risks and to design preventative measures for such possibilities. Relatively little work has been done previously to determine the transport characteristics of oocysts in overland flow. The possible effectiveness of grass strip barriers (a suggested management alternative) is unknown in any detail because the "stickiness" of oocysts to grass blades is unknown. Reliable methods of measuring oocysts in samples with significant amounts of other materials likely to be included in natural runoff flows are also not widely available. Currently accepted methods have been developed primarily for relatively clean water samples. This obviously complicates the evaluation of experimental data, and there is a need to examine in much greater detail than is currently available better methods of measuring oocysts under natural runoff conditions. Ultimately, the present experimental program is designed to measure the "stickiness" of oocysts to different materials, to evaluate the preferred mode of transport (attached to particles or free-floating) and the degree to which oocysts tend to become attached to surface materials such as grass or soil.

A methodology to evaluate potential risks also is currently unavailable, even if the required experimental data were known. To this end, it is desirable to develop a modeling framework to incorporate characteristics of a given watershed of interest, along with oocyst loading and transport characteristics (to be determined in the experiments) and storm event data, so that potential oocysts loading from the watershed may be evaluated.
Dates: Oct 01, 1998 - Mar 30, 2000
Contact: Myles Morse, ORD/NCER, 202-564-6827

- Real-time PCR Method to Detect *Enterococcus faecalis* in Water: Microbial Source Tracking. Fecal enterococci are normal inhabitants of the gastrointestinal tract of animals. Their densities have been shown to correlate better with the incidence of gastrointestinal illnesses in recreational bathers than fecal coliform densities, and consequently, they have been suggested to be a superior bacterial indicator of fecal contamination in recreational waters. A 16S rDNA real-time PCR method was developed to detect *Enterococcus faecalis* in water samples. The dynamic range for cell detection spanned five logs and the detection limit was determined to be 6 cfu/reaction. The assay was capable of detecting *E. faecalis* cells added to biofilms from a simulator of a water distribution system and in freshwater samples. Nucleic acid extraction was not required, permitting the detection of *E. faecalis* cells in less than 3 hours.
Completion Date: Final
Contact: Jorge Santo Domingo, ORD/NRMRL, 513-569-7085

- Assessment of Equine Fecal Contamination: The Search for Alternative Bacterial Source Tracking Targets. Watersheds continue to be impaired in great part due to failure to conclusively identify non-point sources of contamination such as agricultural runoff. Phylogenetic 16S rDNA clone libraries were evaluated for detection of fecal source identifying bacteria from a collapsed equine manure pile. Libraries were constructed using universal eubacterial primers and *Bacteroides-Prevotella* group specific primers. Eubacterial sequences indicated that upstream and downstream water samples were predominantly β and γ *Proteobacteria* (35 and 19 % respectively), while the manure library consisted predominantly of Firmicutes

(31%) and previously unidentified sequences (60%). Manure specific eubacterial sequences were not detectable beyond five meters downstream from pile, suggesting either poor survival or high dilution rates. In contrast, *Bacteroides* and *Prevotella* sp. sequences were detected both in manure and downstream using group specific primers. Novel sequences from *Bacteroides* and *Prevotella* analysis produced an equine specific phylogenetic cluster as compared to previous data sets obtained for human and bovine samples. While these results suggest that some anaerobic fecal bacteria might be potential identifiers for use in source tracking applications, a comprehensive examination of environmental sequences within these species should be performed before methods targeting these bacterial groups are applied to watersheds for development of microbial source tracking protocols.
Completion Date: Final
Contact: Jorge Santo Domingo, ORD/NRMRL, 513-569-7085

- Detecting Fecal Contamination and its Sources in Water and Watersheds. Little is known about the levels and sources of fecal contamination in water. There are thus great uncertainties about human and environmental health risks from pathogens. Furthermore, there is inadequate information to reliably prevent and manage human and animal fecal wastes in water and watersheds and the risks of waterborne disease they pose.

The objectives of this project are to develop, evaluate and apply new and improved methods to detect and trace sources of fecal contamination in surface waters. Emphasis is placed on detecting viable or infectious organisms and distinguishing between human and animal sources of fecal contamination.

Initial applications of our methods are being done in the laboratory using spiked (seeded) samples of water and in the field in watersheds that are well characterized with respect to sources of human and animal fecal wastes. One of the indicators we are using, genotypes of male-specific coliphages, have been detected and quantified in watersheds receiving municipal sewage effluent discharges and were found at progressively higher concentrations nearer sites of known sewage effluent discharge. The detected genotypes or serotypes were those expected in human fecal wastes. In watersheds receiving fecal wastes from agricultural animals (cattle, pigs, and poultry), indicators were found at highest concentrations at sample stations impacted by known fecal waste sources. The detected types were those expected in animal fecal wastes, except when the waste source was pigs. Pig wastes sometimes contained indicator types also found in human wastes. Salmonella are being rapidly detected at low levels by several techniques, including: pre-enrichment, membrane filtration, selective growth on differential/selective media and nucleic acid hybridization.

In laboratory investigations of Cryptosporidium oocyst viability assays in cell cultures, as few as 1-10 live oocysts have been detectable by a specialized assay of active stages (meronts). When oocysts are inactivated (for example, by heat treatment), they are not detectable by this assay. We have made considerable progress in the development and initial field application of new and improved methods to detect indicators of fecal contamination and enteric pathogens in water. Initial field application of these methods shows that levels of indicators are highest nearest sources of fecal contamination. We have a promising approach to distinguish between human and animal sources of fecal contamination in watersheds, but there may be a problem in resolving human from pig fecal waste sources. Cell culture infectivity may prove to be a useful assay to detect low levels of viable Cryptosporidium cysts in water and other environmental samples.

In the future we will further develop, refine and field apply improved methods to detect fecal indicators and enteric pathogens in water. This will be followed by periodic field sampling for enteric bacterial, viral and protozoan pathogens as well as candidate indicator bacteria at a number of well characterized field sites. These field studies will be used to determine the sensitivity, selectivity and specificity of the methods to detect fecal pathogens and their indicators in watersheds and to trace and identify fecal waste sources.
Dates: Oct 01, 1995 - Oct 31, 1998
Contact: Myles Morse, ORD/NCER, 202-564-6827

Effects Characterization

- **Endocrine Disrupting Effects of Cattle Feedlot Effluent on an Aquatic Sentinel Species, the Fathead Minnow**. Previous research has suggested endocrine disrupting effects of components of feedlot effluent, and evidence has been presented that one component, trenbolone, can act as an environmental androgen and reproductive toxicant in rats and fathead minnows under laboratory conditions. However, studies of feedlot runoff effects on an environmental species in the wild was lacking. This study determined that endocrine disruption could be detected in natural stream and river systems below feedlots by examining the reproductive endocrinology and secondary sex characteristics of native fish populations. The data clearly demonstrate androgenic activity from water obtained below feedlots. However, it does not identify the causal agents.

Products:

This paper has been submitted to *Environmental Health Perspectives*. Orlando, E.F., Kolok, A.S., Binzcik, G.A., Gates, J.L., Horton, M.K., Lambright, C.S., Gray, L.E.,Jr., Soto, A.M., and Guillette, L.J. Endocrine Disrupting Effects of Cattle Feedlot Effluent on an Aquatic Sentinel Species, the Fathead Minnow.

Contact: L. Earl Gray, Jr., ORD/NHEERL, 919-541-7750

- **Prevalence and Distribution of Genotypes of *Cryptosporidium parvum* in Feedlots in the Western United States**. The overall goal of the proposed research is to determine the prevalence of fecal shedding, distribution of genotypes, and associated risk factors for Cryptosporidium parvum (C. parvum) infection in populations of feedlot cattle in the United States. Infection with C. parvum in calves raised on commercial dairy farms is quite common. Cumulative incidence of infection often exceeds 90% within the first 30 days of life and as many as 107 oocysts/g may be shed in the feces of infected calves. In contrast, relatively little is known regarding the prevalence and intensity of fecal shedding of C. parvum in feedlot cattle. Although the older age of feedlot cattle suggests that C. parvum shedding will be of low intensity, these confined animal feeding operations (CAFO's) are comprised of cattle from a wide variety of geographical locations, animals which may be under varying levels of physiological stress and which are fed variable levels of grain which may collectively enhance the shedding of this zoonotic parasite. Recent evidence indicates that there are distinct genotypes of C. parvum which may differ in infectivity and virulence for humans and other mammalian hosts. Potential strain or genotype differences of C. parvum within populations of feedlot cattle may exist. To address these animal and human health issues and to develop strategies for minimizing environmental contamination of C. parvum from feedlot cattle, our project has the following objectives:

1) Determine the prevalence and concentration of C. parvum oocysts in fecal samples from feedlot cattle in the United States. This will allow us to determine the significance of feedlot cattle as an environmental source of oocysts and to begin to calculate valid loading equations for the rate at which feedlot operations produce C. parvum oocysts.

2) Determine the distribution of genotypes of C. parvum actively shed by feedlot cattle. This objective is designed to determine which genotypes of C. parvum are present in United States feedlot cattle. We will determine how genotypes are spatially distributed and whether geographic origin is predictive of genotype.
3)Determine animal and pen-level management factors associated with a fecal sample testing positive for specific genotypes of C. parvum. This objective is designed to identify feedlot management practices which will minimize water quality and public health impacts from CAFO's and provide critical input for Comprehensive Nutrient Management Plans targeted for this segment of the cattle industry.

Dates: Apr 01, 2000 - Mar 31, 2002

Contact: Myles Morse, ORD/NCER, 202-564-6827

- **Workshop Proceedings on Emerging Infectious Disease Agents and Issues Associated with Animal Manures, Biosolids and Other Similar By-products (June 4 - 6, 2001).** Technical material in the proceedings is being updated to 2003 and peer reviewed. Pathogen lists will be complete. The final product will be an assessment of the State of the Science associated with the occurrence, detection, and destruction of infectious disease agents in manure, sewage sludge/biosolids, and other waste processing byproducts that

are usually treated with existing technologies and subsequently beneficially utilized. It will begin with an overview of the workshop's presentations and discussions. This will be followed by a section titled Synthesis and Interpretation of Workshop Proceedings. Citation planned for the publication is Smith, J. E. Jr., P. Millner, W. Jakubowski, N. Goldstein and R. Rynk, Eds. Fall, 2003. Contemporary Perspectives On Infectious Disease Agents In Sewage Sludge And Manure. Compost Science & Utilization/The JG Press, Inc.
Date: Jun 01, 2003
Contact: James E. Smith, ORD/NRMRL, 513-569-7355

MANAGEMENT PRACTICES

Manure Management Practices

- Report on the stressor reduction (nitrogen, phosphorus, pathogens, EDCs, antibiotics, and airborne nitrogen, particulate and pathogens) achievable using existing manure management practices at CAFOs. To understand how existing manure management practices at CAFOs serve to reduce the release of nutrients, pathogens, EDC and antibiotics into the watershed. Stressors can be released as the result of runoff, subsurface transport and windborne transport followed by subsequent redeposition into receiving waters. Since subsubsurface stressor transport is being addressed under another APM, this research will focus on transfer due to runoff and windborne transport.
Dates: Expected Completion 9/04
Contact: Laurel Staley, ORD/NRMRL, 513-569-7863

- Arsenic Speciation Methods Applied to Studying the Environmental Fate of Organoarsenical Animal Feed Additives. Research will provide analytical methods to measure a number of inorganic and organic arsenic species in a variety of environmental matrices (poultry litter, litter-amended soils, and natural water). These methods will be used to elucidate the environmental transformations undergone by organoarsenic animal-feed additives and determine if the potential exists for substantially increased exposure of humans and aquatic organisms to arsenic. HPLC methods of speciating the organoarsenical pharmaceutical compounds are being used with capillary electrophoresis being employed as an alternative approach. A regional laboratory chemist will be assisting ORD on this effort, under the Research Partnership Program. This research could be expanded to include targeted field measurements using these analytical methods.
Dates: FY 2000 - FY 2005
Contact: ORD/NERL - Ed Heithmar, 702-798-2626; George-Marie Monplaisir, 702-798-2255 (HPCL Method); Charlita Rosal,702-798-2179 (Capillary Electrophoresis Method)

- Capstone Report on Methods to Reduce Environmental Risk from Nutrients, Pathogens, and Hormones from CAFO Manure Management Practices. The objective of this report is to provide performance and cost information on manure management practices that mitigate the release of nutrients, pathogens, and hormones from manure management practices at animal feeding operations. Research in this area will encompass ORD National Risk Management Research Laboratory (NRMRL) in-house research as well as collaborative efforts with states (particularly North Carolina)**,** USDA (especially the Land Grant Universities) and other organizations within and outside EPA focused on the development and evaluation of manure management strategies which reduce the release of nutrients, hormones and pathogens from CAFOs.
Dates: FY 2004 - FY 2007
Contact: John Haines, ORD/NRMRL, 513-569-7446

Alternative Manure Management Practices

- **EPA's ETV Greenhouse Gas Technology Center**. The Greenhouse Gas Environmental Technology Verification Center has several active biogas technology verifications in process now: (1) a reciprocating engine-CHP unit burning biogas from a swine waste digester, (2) a micro-turbine-CHP burning biogas from the same swine waste digester, (3) a microturbine-CHP burning biogas from a dairy farm digester, and (4) an animal waste additive which increases biogas yield and decreases criteria pollutants emissions. All of these applications convert biological waste into renewable energy, while reducing on-farm energy costs and in some instances, producing excess electricity for sale to the grid. Also, they can produce marketable by-products such as soil amendments while simultaneously mitigating air pollutants, GHG emissions, water pollution and nuisance odors.
Dates: FY 2002 - FY 2004
Contact: David Kirchgessner, ORD/NRMRL, 919-541-4021

- **Recycling Process for Poultry Litter - Phase I**. A low-temperature, catalytic tertiary conversion process for recycling organic materials is proposed for application to turkey litter and other animal waste. This platform technology delivers rapid capture of valuable nutrient resources in a closed, nonpolluting system and can maintain the physical properties of materials treated or reduce them into a fine, dense ash. Current environmental problems associated with disposal of poultry and swine wastes provide excellent opportunities for use of this recycling technology to minimize the volume of litter, manure, and mortalities requiring disposal; sterilize litter material for reuse in multiple rotations; and reclaim valuable nutrient and mineral resources using a safe, closed system.

Recycling reactors based on this technology are easily adapted for permanent on-farm installation as well as truck-mounted portable units. This technology should provide economically viable treatment options for poultry and swine waste streams even before the values of reclaimed resources are considered. Successful deployment of this technology to poultry and livestock producers will result in increased food and worker safety, reduced risk of environmental contamination, enhanced producer profit margins, and increased rural property values. Related technologies are being commercialized for recycling scrap plastics and electronic, aircraft, and automotive parts.
Dates: Sep 01, 1999 - Mar 01, 2000
Contact: Myles Morse, ORD/NCER, 202-564-6827

Effects Assessments

- **Soil Ecotoxicity Assays.** In remediation of hazardous wastes, soil ecotoxicity assays are useful in evaluating performance when combined with chemical measures. The use of bioassay testing can strengthen these evaluations in several ways. First, since bioassay testing is a direct measure of the hazard associated with a specific soil, bioassay testing is a more reliable way of describing the hazard than estimates based on chemical concentrations. Secondly, bioassay testing evaluates the aggregate effect of the soil on the reporting organisms, and thus, includes aspects such as soil matrix effects, sorption/desorption behavior, bioavailability, and chemical mixture interactions. Finally, by evaluating the toxicity of soil following remedial technology processing, increased toxicity due to incomplete treatment or toxicity introduced by process amendments can be identified. For example, in bioremediation processes, incomplete degradation of target contaminants is a common concern. By monitoring the toxicity of a soil before and after treatment, researchers have hard data to support claims that a treatment is effective. It would be difficult to monitor biodegradation products in any other way due to the large number of these compounds that can potentially be formed.

As EPA researches environmental concerns associated with CAFOs and biosolids, the soil ecotoxicity lessons are also applicable. A common disposal practice for municipal biosolids and CAFO manures is to spread this material on agricultural fields as a soil amendment. Recently, questions have arisen about this practice. In some preliminary research, earthworm mortality increased when earthworms were exposed to biosolids mixed with an innocuous sediment. Plant growth was also reduced as measured by lettuce and oat root length. This toxicity persisted despite weekly aeration. Since biosolids and CAFO wastes are applied as a soil amendments, adverse responses by soil organisms are concerning.

Currently, soil ecotoxicity is evaluated using the 14-day earthworm mortality test, and the 5-day seed germination and root elongation test with lettuce and oats. Longer term plant tests and non-lethal earthworm assays will be developed. Samples contaminated with CAFO and biosolids will be tested to evaluate whether soil organisms are adversely affected at the levels applied and whether effects on soil organisms persist.
Dates: Jan 01, 1997 - Dec 31, 2006
Contact: Carolyn Acheson, ORD/NRMRL, 513-569-7190

Pollution Prevention Practices

- Technologies Toward a Zero-Discharge, Energy-Efficient CAFO: **Report on CAFO pollution prevention opportunities and a framework for successful implementation**. The objective is to develop cutting edge air handling, biosolids (manure), and wastewater reuse technologies to move CAFO operations to low-emission and improved resource efficiency.

This project is examining the development and implementation of pollution prevention techniques to minimize water usage at a CAFO facility. Membrane separation technology will be developed and demonstrated to explore the possibility of closed-loop recovery and reuse of wastewater from CAFOs focusing on the separation of EDCs, hormones, pathogens and other contaminants that are problematic in CAFO wastewater streams. Technology development and implementation will also focus on air handling and recirculation using filtration and separation techniques to reduce or eliminate pathogens, ammonia, odor and other air emissions.

To address manure disposal issues, this project is employing process engineering techniques to optimize methane gas production from manure and the conversion of methane gas to energy for use at the CAFO. This project explores the latest developments in reactor design to optimize the manure composting process to decrease the amount of time necessary for conversion of manure to compost. In addition to compost production research, this project is analyzing the soil enhancement qualities of the compost. This research will also explore the possibility of alternative end use markets for compost such as landscaping and erosion protection in addition to redistribution on farms.
Dates: FY 2003 - FY 2006
Contact: Johnny Springer, ORD/NRMRL, 513-569-7542

- Upgrading Poultry Processing Facilities to Reduce Pollution
Products:

Upgrading Poultry Processing Facilities to Reduce Pollution - Volume 1. U.S. Environmental Protection Agency, Washington, D.C. EPA/625/3-73/001a.

Upgrading Poultry Processing Facilities to Reduce Pollution - Volume 2 - Pretreatment. U.S. Environmental Protection Agency, Washington, D.C. EPA/625/3-73/001b.

Upgrading Poultry Processing Facilities to Reduce Pollution - Volume 3 - Waste Treatment. U.S. Environmental Protection Agency, Washington, D.C. EPA/625/3-73/001c.

Contact: Thomasine Bayless, ORD/NRMRL, 513-569-7748

Risk Management Evaluation

- **CAFO Risk Management Evaluation**. The Risk Management Evaluation (RME) document describes the potential for environmental risk arising from Concentrated Animal Feeding Operations (CAFOs) in the United States. The RME presents a discussion of the changes in animal agriculture production in the United States and the potential waste production from the different animal sectors. Since about 1970, production in animal agriculture in the Unites States has undergone a transformation unprecedented in scale. Production facilities have become concentrated in both locale and numbers of animals resident on the facility. The concentration of production has been driven by economic factors that favor large scale operations. Unit costs of feed, housing, and animal care are lower in a concentrated facility as opposed to smaller scattered farms. As the production of meat, milk, pork, and poultry has become more concentrated, the attendant production of animal manure has become more concentrated. The traditional practice of applying manure to land as a disposal route and as a mode of fertilization is limited with regard to CAFOs. The large quantities of waste require correspondingly large land areas for application to avoid overapplication of nutrients. In most cases the CAFO does not control enough land area to absorb all of the waste generated. One option has been to contract with neighboring farms to accept waste as a fertilizer. Progress has been made in developing a market for manure as a fertilizer or soil conditioner. The limiting factor is the cost associated with transport of the material from the production site to the use site.

The characteristics of manure from the different animals are presented along with current common management practices. The major environmental stressors identified with animal waste are presented with regard to the potential for environmental impact. Nutrients, pathogens, antibiotics, EDCs, metals, and sediments are given consideration as possible sources of environmental risk. Examples of effects of different stressors are presented. Each stressor presents unique problems with regard to control of its dissemination in the environment. Some stressors move with water through the soil to groundwater, some move with eroded soil sediments, some move in the air, and some move in more than one medium. Overland flow with runoff, groundwater flow and air transport of different stressors is discussed.

Management of risks from CAFO wastes is a changing field of work. Land application can be done, but more states are requiring adjustment of rates of application to be keyed to nitrogen or phosphorus at agronomic rates. Using a phosphorus limit requires much more land than a nitrogen limit. Encouraging farming methods that will reduce erosion of soil and with it the nutrients and other stressors found in manures is another aspect of waste management receiving more attention. Finding alternate uses for animal waste is a developing field of research. The most commonly applied alternatives include composting, methane generation and land reclamation. In composting, wastes are reduced in mass, nitrogen is lost, and the burden of pathogenic organisms is greatly reduced. Composting can be developed to provide salable products for the consumer market such as custom potting soil mixes, soil amendments for gardening, and large scale uses in crop production. Anaerobic digestion of animal wastes can provide methane for energy generation. Many facilities use methane to power generators to provide electricity for use on the farm and to sell to the distribution grid. In many cases the generation of electricity can offset the cost of installing the necessary equipment. The residual material from anaerobic digesters is reduced in mass, nitrogen , and potentially pathogenic bacteria. Constructed wetlands can also be used to treat wastes from CAFOs. The wetlands can be efficient sinks for nitrogen and sediments from agricultural operations. Maintenance will be required to maintain capacity over time. Aerobic digestion of animal wastes can be done in a manner similar to systems used to treat human wastes. The processes are well understood, but the limiting factor is the cost to build such treatment facilities. Aerobic digesters provide treatment of the waste reducing the mass to be handled but no further benefit. Another potential use for CAFO waste is in reclamation of damaged land surfaces. Severely eroded lands, surface mined lands, and landfill covers all can benefit from an infusion of organic matter into the soil. Soil organic matter improves water holding, workability, and fertility. Damaged lands would benefit greatly from the organic matter in animal manures.

Potential CAFO waste research areas are identified in the RME. There are needs for new and better methods to identify and quantify environmental stressors. There is work needed to improve waste management processes including anaerobic digestion, aerobic digestion, composting and other methods for treating animal wastes. The fate and effects of many stressors in the environment is largely unknown. Do antibiotics have an effect on native bacterial populations? Are resistance factors transmitted in the environment? How far are pathogenic organisms transported in the environment? How long do pathogens survive? Can we identify the source of stressors? How effective are riparian buffers in limiting the movement of different stressors? How can we reduce the production of aerosols from CAFOs? Do aerosols pose a significant risk to nearby persons or farms? What are those risks?
Dates: In final review stage
Contact: John Haines, ORD/NRMRL, 513-569-7446

- Environmental Justice Assessment of Industrial Pork Production in Mississippi and North Carolina. There are large numbers of industrial swine operations that may pose a risk to the health and quality of life of these communities if the industry continues to grow at its current pace. This study intends to evaluate this situation as one of the major and emerging environmental justice problems in the south.
Dates: Jul 01, 2000 - Jul 01, 2003
Contact: Myles Morse, ORD/NCER, 202-564-6827